EXHIBIT 1

TO

EXHIBIT A

(PART 1)

#10 ^M^
3-12-97

PATENT
DOCKET NO: MCR-2CIP

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	John H. Cafarella et al.
Serial Number:	08/369,778
Filing Date:	December 30, 1994
Title:	High-Data-Rate Wireless Local-Area Network
Group Number:	2614
Date:	February 13, 1997

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

DECLARATION OF JEFFREY H. FISCHER UNDER 37 C.F.R. §1.131

I, Jeffrey H. Fischer, declare as follows:

1. I am one of the named inventors in the above-identified application and still reside at One Emerson Place, Apartment 14N, Boston, MA 02114 USA.

2. I am currently employed by Micrilor, Inc. of Wakefield, MA, the current assignee of the above-identified application, in the capacity of Senior Engineer and have been since October 1986 in that capacity.

3. I have reviewed the Official Action of October 17, 1996, and the references cited by the Examiner, in connection with the above-identified application.

4. Prior to March 27, 1992, i.e., prior to the effective dates of the Gilhousen et al., Padovani et al. and Lundquist et al. patents, Micrilor prepared and submitted a proposal for a Small Business Innovation Research (SBIR) grant under a Program of the U.S. Department of Defense. A true copy of the proposal is attached as Exhibit A, except that it has been redacted to exclude all references to dates, including the topic number and internal reference number. As indicated, the proposal related to the design and development of the feasibility of a specific architecture of a high data rate wireless LAN designed to overcome intersymbol interference (ISI) when transmitting data through a multipath channel. The proposed LAN utilized a combination of orthogonal signaling, in the form of M-ary orthogonal signaling (which by itself is normally prohibited by the narrowband channel

allocations available), with DS spread-spectrum, preferably using Walsh Function modulation/demodulation.

5. Prior to March 27, 1992, Micrilor, Inc. was given a grant by the Department of Defense in response to the proposal.

6. Prior to March 27, 1992, and during efforts to comply with the grant, I with the help of my co-inventor, John H. Cafarella, created a computer program to simulate a specific architecture of a high data rate wireless LAN utilizing a combination of orthogonal signaling, in the form of M-ary orthogonal signaling with a Walsh Function modulation/demodulation and DS spread-sprectrum. The computer-simulated system was designed and source code written using a commercial simulation program sold under the name Matlab, to simulate, and did successfully simulate, all of the features set forth in the rejected claims 1, 2, 4, 5, 8, 9, 11, 12, 16, 17, 20-25, 27, 57, 58, 62-64, 66-77 and 79. A true copy of the Matlab source code is attached as Exhibit B

7. Prior to March 27, 1992, in addition a demonstration of the modulation/demodulation for a high data rate LAN utilizing a combination of orthogonal signaling, in the form of M-ary orthogonal signaling with a Walsh Function modulation/demodulation and DS spread-sprectrum, was constructed on a printed circuit board and successfully tested as operational. Drawings in connection with this construction were prepared prior to March 27, 1992. Attached as Exhibit C is a true copy of a schematic drawing of the printed circuit board that was constructed at the time, except that the drawing has been redacted to exclude the date the drawing was prepared. Attached as Exhibit D is a true copy of a printed circuit board layout of the printed circuit board constructed at that time. Exhibit E is a true copy of a drawing of the gate array layout used in constructing the printed circuit board at that time. Exhibit F is a true copy of a block diagram of the printed circuit board constructed at the time. The system constructed on the printed circuit board was designed to perform, and did successfully perform, all of the features set forth in the rejected claims 1, 2, 4, 5, 8, 9, 11, 12, 16, 17, 20-25, 27, 57, 58, 62-64, 66-77 and 79.

8. Prior to September 7, 1993, i.e., prior to the effective dates of the Padovani et al. and Lundquist et al. patents, I, my co-inventor John H. Cafarella, and Iwen Yao and Kendrick R. Bennett wrote and submitted a final report to the U.S. Army Communications

and Electronics Command detailing the implementation of a system built in accordance with the grant. A true copy of the final report is attached as Exhibit H, except that the document has been redacted to exclude all references to dates, including the contract number and internal document number.

9. As further support of conception of the subject matter of claims 1, 2, 4, 5, 8, 9, 11, 12, 16, 17, 20-25, 27, 57, 58, 62-64, 66-77 and 79, on June 7, 1993, prior to the effective dates of the Padovani et al. and Lundquist et al. patents, but after the events described in paragraphs 4-8, I with my co-inventor, John H. Cafarella, filed a disclosure document together with the required fee, and received a communication from the United States Patent and Trademark Office acknowledgment that the document was considered filed and was accorded Disclosure Document No. 331998. A true copy if the disclosure document and the response received from the United States Patent and Trademark Office is attached as Exhibit H.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

13 Feb, 1997
Date

Jeffrey H. Fischer

Exhibit A

APPENDIX A

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET
Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMB: ______

PROPOSAL TITLE: High-Data-Rate Wireless LAN for Tactical Multimedia Networks

FIRM NAME: MICRILOR, Inc.

MAIL ADDRESS: 17 Lakeside Office Park North Avenue

CITY: Wakefield, STATE: MA ZIP: 01880

PROPOSED COST: $70,769 PHASE I OR II PROPOSAL: I PROPOSED DURATION IN MONTHS: ______

BUSINESS CERTIFICATION

	YES	NO
▶ Are you a small business as described in paragraph 2.2?	☒	☐
▶ Are you a minority or small disadvantaged business as defined in paragraph 2.3?	☐	☒
▶ Are you a woman-owned small business as described in paragraph 2.4?	☐	☒
▶ Has this proposal been submitted to other US government agency/agencies; or DoD components, or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office in the spaces to the left below. If it has been submitted to another SBIR activity list the Topic Numbers in the spaces to the right below.	☐	☒

▶ Number of employees including all affiliates (average for preceding 12 months): 8

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: John H. Cafarella	NAME: Stanley A. Reible
TITLE: Senior Scientist	TITLE: Vice President
TELEPHONE: (617)246-0103	TELEPHONE: (617)246-0103

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: Pages 4 to 10.

DISCLOSURE PERMISSION STATEMENTS: All data on Appendix A are releasable. All data on Appendix B, of an awarded contract, are also releasable.

J H Cafarella ______ Stanley Reible ______

SIGNATURE OF PRINCIPAL INVESTIGATOR — DATE — SIGNATURE OF CORPORATE BUSINESS OFFICIAL — DATE

Note: ... this page is classified or proprietary information data
Proposal page No. 1

APPENDIX B

DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

TOPIC NUMBER ____________________

PROPOSAL TITLE High-Data-Rate Wireless LAN for Tactical Multimedia Networks

FIRM NAME MICRILOR, Inc.

PHASE I or II PROPOSAL I

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

The requirements for high-data-rate connectivity in tactical Army deployments continues to exceed the rates available using emerging communications systems; these systems, which normally address the battlefield survivability problem by using considerable spectrum spreading, offer relatively low data rates and they also are very expensive. An alternate architecture for achieving the desired high-rate connectivity is to reduce the amount of protection obtained through spread-spectrum signaling, and to substitute a combination of antenna directivity and absorptive propagation behavior. On the other hand, it is not desirable to completely remove spread-spectrum signaling for several reasons. By including a modest amount of spreading, a hybrid approach to reduced probability of detection (RPD) can be effected, as can be the reduction of fading and/or intersymbol interference. This approach could lead to robust, survivable links which support 10-Mbit/sec wireless LAN operation in a multimedia network.

Anticipated Benefits/Potential Commercial Applications of the Research or Development

The effort will provide a high-data-rate wireless LAN system design concept, and development of a demodulator chip required for the realization of low-cost, high-data-rate spread-spectrum communication in multipath.

List a maximum of 8 Key Words that describe the Project.

radio	wireless
LAN	Ethernet
tactical	survivable

CONTENTS

1 IDENTIFICATION AND SIGNIFICANCE OF PROBLEM

1.1 Motivation

The requirements for high-data-rate connectivity in tactical Army deployments continues to exceed the rates available using emerging communications systems; these systems, which normally address the battlefield survivability problem by using considerable spectrum spreading, offer relatively low data rates and they also are very expensive. An alternate architecture for achieving the desired high-rate connectivity is to reduce the amount of protection obtained through spread-spectrum signaling, and to substitute a combination of antenna directivity and absorptive propagation behavior. On the other hand, it is not desirable to completely remove spread-spectrum signaling.

The use of absorption can provide tremendous enhancement of survivability by denying detection by the enemy's long-range surveillance assets; however, the use of absorption actually increases the detectability for an unintended receiver at nearer ranges. Thus, by including a modest amount of spreading, a hybrid approach to reduced probability of detection (RPD) can be effected which offers excellent protection against sophisticated stand-off surveillance and also against simpler intercept threats which might be closer to friendly locations. Another benefit of spread-spectrum signaling is the reduction of fading and/or intersymbol interference (ISI). Since each of these effects could potentially require increased transmitter power if spread spectrum were not used, there is a secondary enhancement of survivability besides the conventional RPD due to spreading. The problem, then, is to employ spread-spectrum signaling in order to gain its advantages without using up too much of the available bandwidth or greatly increasing the equipment cost.

MICRILOR, Inc. has been developing low-cost spread-spectrum equipment for commercial applications. A 19.2-kbaud, full-duplex modem employing 15-Mchip/sec direct-sequence (DS) signaling is to be introduced to the market place during 1991; this modem is projected to sell for under $1000. Anticipating the demand for higher data rates, consistent for example with Ethernet, MICRILOR has developed concepts for signaling at up to 10 Mbit/sec using modest spectral spreading combined with orthogonal signaling with a high-level alphabet. In the commercial domain, this approach is expected to combat fading, reduce ISI, and provide modest security for short-range in-door networking. On the other hand, the same approach could be combined with the tactical network architecture to cost-effectively incorporate modest spreading.

2 PHASE I TECHNICAL OBJECTIVES

2.1 High Data Rates in Multipath

The principle barrier to high-rate communications in a tactical ground-to-ground environment is the multipath nature of the channel. When transmitting binary waveforms whose duration is shorter than the spread in multipath delays, the channel response to each data bit overlaps that of other bits; this effect is called intersymbol interference (ISI). In a typical short-range (<1 km) link in open country (not downtown) this multipath spread might be about 1 μsec, which would imply a maximum data rate of 1 Mbit/sec for binary signaling. (This multipath spread would be somewhat reduced in the network architecture based upon microwave links with modest gain because the longest delays often correspond to angles far from bore-sight.) One effective means for overcoming this limitation is to employ a higher-level signaling alphabet, i.e. send a "symbol" waveform whose duration is longer than the multipath spread, but which conveys multiple bits per symbol.[1] A natural set of orthogonal waveforms for "M-ary signaling" is the so-called Walsh functions;[2] these can be digitally generated and readily processed.

The use of M-ary orthogonal signaling is normally prohibited by the narrowband channel allocations available; in order to convey n bits per symbol the bandwidth required is $m=2^n$ times the symbol rate, and this exponential scaling rapidly expands the bandwidth. When it is intended, however, to employ spread-spectrum in the form of direct sequence, then the expansion due to M-ary signaling can be made to approach the spread-spectrum bandwidth without burden. Thus, we see that the combination of orthogonal signaling with DS spread-spectrum is a very natural approach to high-data-rate communication in multipath. In fact, a further attractive feature of this approach is that, when the multipath spread does occasionally exceed the symbol duration, then the use of changing codes for spreading results in randomization of the effects of ISI, which would enable coding to be employed to help overcome this residual ISI.

2.2 Walsh-Function Signaling

Figure 1 shows the probability of correctly demodulating a 1024-bit packet using DPSK spread-spectrum signaling and also using M-ary spread-spectrum with 2, 4 and 8 bits per symbol. It must be stressed here that the use of orthogonal signaling is a form of coding; if the DPSK modulation were combined with coding, it would also shift to a lower required S/J ratio. Figure 2 gives the same curves on an expanded scale. Note that the use of 4-ary orthogonal (2 bits/symbol) is essentially equivalent to DPSK, and that a higher signaling alphabet can be used to considerable effect. For an uncoded link, the above curve imply that the processing gain achieved by combining orthogonal signaling with DS spread spectrum is larger, for a fixed bandwidth. Thus, a transmission using 4 bits/symbol and a DS bandwidth of 80 MHz would exhibit the same nominal processing gain as a transmission using DPSK and a DS bandwidth of about 130 MHz!

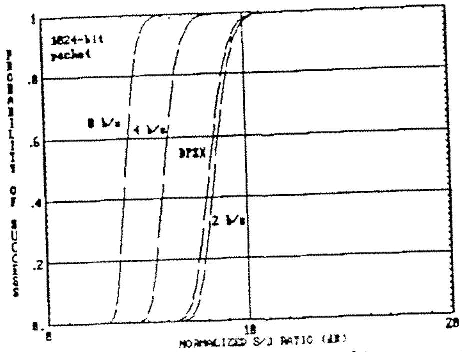


Figure 1 - Probability of correctly demodulating a 1024-bit packet.

It is important here to note the selection of Walsh functions here as the orthogonal set. In JTIDS a rotation of the DS code known as cyclic code-shift keying (CCSK) was used; this produced, at the processor output, the equivalent of pulse-position modulation (PPM). In a multipath environment the PPM-like behavior of CCSK can be very detrimental because the delay discriminant used for demodulation can be directly confused with multipath. Thus, it is preferable to use some other orthogonal set. If the bandwidth expansion due to the orthogonal signaling is much smaller than the DS spreading, then

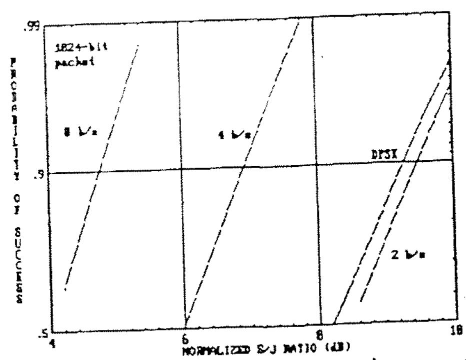


Figure 2 - Expanded view of demodulation performance.

one might use essentially any orthogonal set; in this case a convenient choice would be a set of tones (i.e., M-FSK) which could be demodulated using FFT techniques after the spreading code is stripped off. However, when the spreading due to the orthogonal signaling approaches that of the DS, then the actual bandwidth will depend upon both the DS and orthogonal modulation. It is interesting that CCSK and the use of Walsh functions both have the property that the bandwidth required for orthogonal signaling can equal the DS bandwidth without further expansion of the signal bandwidth over that of the DS. Thus, we see that for confining the bandwidth and performance in multipath, the Walsh functions are a natural choice.

2.3 Walsh Function Correlation Processors

In this section, we assume that the reference DS code is properly aligned with the received signal, and that the two are multiplied, and then low-pass filtered to support processing the highest Walsh function. (This generally may be lower than the chip rate.) This has the effect of "stripping off the DS code, leaving only the Walsh function modulation. The discussion below considers baseband processing; in an actual implementation the signal would be converted to inphase and quadrature channels, and the baseband processing described below would be performed in each channel, followed by envelope combining of corresponding amplitudes before data decision.

2.3.1 Fast Walsh Transform

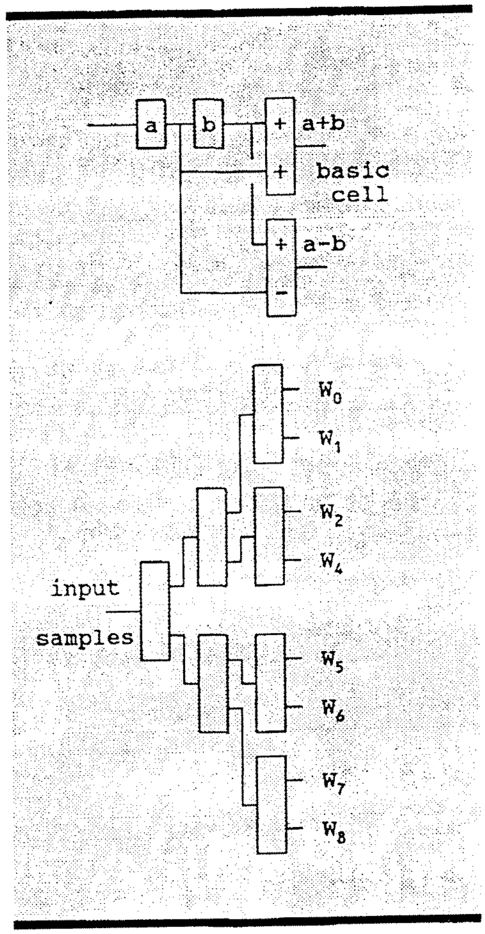
The Walsh functions exhibit group properties analogous to the basis functions of the discrete Fourier transform, but the Walsh functions are even more convenient. For example, the standard decimation-in-frequency (DIF) FFT performs an N-point transform by computing two N/2-point transforms of adjacent time frames and then combining these with appropriate "twiddle factors." The DIF algorithm (or decimation-in-sequency algorithm for sticklers) for the fast Walsh transform (FWT) is extremely similar, but the twiddle factors are all unity!

Beauchamp's book (reference 2) gives the FWT algorithm explicitly. We will not dwell here on the FWT. In using a transform, there are two problems: there is essentially a full time-frame of latency in computing the transform, and data must be buffered. This may be somewhat softened by using a pipelined transform, but generally the use of a transform will be reserved for applications which are conducive to software implementation.

2.3.2 Pipelined Radamacher-Decomposition Correlator

Another approach to realizing the correlator is to compute the coefficients in a pipelined structure, utilizing the structure of the Walsh functions to reduce the clock rate of successive stages which are increasing in the number of parallel cells, thus keeping the power per stage nearly constant.

A basic cell accepts input samples at rate f_{in} and generates two output samples at rate $f_{in}/2$: one output sample is the sum of the current pair of input samples and the other is the difference of these two input samples. The basic cell and a tree for decoding the first 8 Walsh functions is shown below. Notice that a particular path through this tree corresponds to multiplying the input sequence by a specific combination of square-wave functions and summing the result. There is a natural conservation of power in that each successive stage has twice the hardware but runs at half the clock rate.



3 PHASE I WORK PLAN

3.1 Design Wireless LAN Link Architecture

With guidance from the sponsor, develop a wireless link architecture which fits within the Army's concepts for multimedia tactical data networks, and which meets the requirements for a specific mission. For example, wireless bridging between Ethernets within several shelters forming a dispersed command post is an attractive application. The RF transmissions are likely to be microwave, with some form of multibeam antennas, as dictated by the Army.

3.2 Design Link Communications

Based upon the bandwidth available, the data-link layer protocol selected, and the estimated channel characteristics, design a self-consistent modulation, coding, spreading, block format, etc. which yields 10 Mbit/sec data rate through the required multipath spread and which occupies no more than 80- to 100-MHz bandwidth. Complete a conceptual design of the data link subsystem required to effect the acquisition, synchronization, data recovery and link maintenance.

3.3 Design and Demonstrate Demodulator Chip

A critical component required for the realization of the high-level M-ary signaling technique is a demodulator chip suitable for computing the correlation coefficients (likelihoods) for the M possible symbol waveforms during each symbol duration. A trade-off study would be carried out to determine the best algorithm and chip architecture for a Walsh-function demodulator chip. An implementation of this chip would be realized in field-programmable-gate-array technology. This represents a low-cost approach to implementing the chip, but is also provides a future path to custom VLSI implementation if that becomes desirable.

3.4 Feasibility Demonstration Plan

With the overall system design completed, and the critical demodulator chip developed, a plan for a feasibility demonstration of one, or several, links would next be undertaken. This demonstration would be proposed as a task under a Phase II SBIR, and would result in brassboard hardware deployed in a testbed in order to establish the practicality of this approach.

3.5 Schedule of Work

The following work would be carried out during the 6-month study and development with the following schedule.

Month	Activity
One	Study overall system architecture.
Two	Design link.
Three-Five	Develop Walsh demodulator chip in field-programmable gate array.
Five	Plan feasibility demonstration for Phase II.
Six	Provide an oral and a final written report of the results of the study and development effort.

4 RELATED WORK

MICRILOR specializes in the applications of advanced signal-processing techniques and technologies; much of their current work focuses upon spread-spectrum communications and advanced radar. The work of MICRILOR personnel, while employed at MIT Lincoln Laboratory, contributed to the theory and technology for radio communications in a dense ground-multipath environment.

MICRILOR is currently developing spread spectrum technology for commercial computer-to-computer communications. MICRILOR has recently received a Navy contract to develop spread-spectrum technology for short-range underwater communications.

5 REFERENCES

1. J. M. Wozencraft and I. M. Jacobs, Principles of Communication Engineering. New York: Wiley & Sons, 1965, pp. 257-266.

2. K. G. Beauchamp, Applications of Walsh and Related Functions. New York: Academic Press, 1984.

6 RELATIONSHIP WITH FUTURE RESEARCH AND DEVELOPMENT

The results of this phase I program would be a design of a wireless LAN concept consistent with use in a tactical multi-media network, and demonstration of the critical demodulator chip required to effect high-data-rate communication in multipath with modest spectral spreading. A phase II program would be proposed to demonstrate full operation of the links in an appropriate testbed. A phase III effort could lead to the construction by MICRILOR of modems for use in an Army testbed.

7 POTENTIAL POST APPLICATIONS

The technology and networking techniques which are developed under the work proposed herein would provide robust, high-rate data communications over moderate ranges in a multipath environment. The ability to provide low-power, wireless data transmission in a multipath environment could be applied to a variety of both military and nonmilitary applications. While this proposal addresses the particular need in a tactical environment for rapidly reconfigurable (hence wireless) links, there is a general need in many organizations for the ability to establish a network quickly after a disruption. For example, when personnel are moved it is frequently necessary to wait weeks for the electricians to re-connect wires for LAN access; wireless LAN connections enable a user to immediately resume productive work after a move.

8 KEY PERSONNEL

8.1 John H. Cafarella

John Cafarella received the B.S.E.E. from Northeastern University in 1970, and the M.S., E.E., and Sc.D. degrees from Massachusetts Institute of Technology in 1972, 1973 and 1975, respectively. His graduate studies concentrated in electromagnetic and acoustic fields, and in solid-state physics. His thesis research was in surface-acoustic-wave signal-processing devices.

While attending MIT graduate school John was a research assistant at Lincoln Laboratory, and he subsequently joined the Laboratory as a staff member in 1974. He demonstrated the first engineered acoustoelectric convolver in 1975, and began to pursue the application of this device to spread-spectrum communication. While he continued to work in subsequent years on various SAW devices, he began to work actively with systems groups to explore the radar and communications applications of these devices. In the summer of 1975, he attended the Military Intelligence Officer's Basic Course at Ft. Huachuca, AZ, and subsequently spent reserve assignments at the National Security Agency. This experience, combined with the radar and communications experience at Lincoln Lab, has resulted in a unique insight into military systems.

Having extensive knowledge of devices, circuits and signal processing, John established an activity aimed at rapidly connecting emerging components to systems. This has resulted in the development of a complete spread-spectrum radio suited to the needs of tactical communication, and of a hybrid radar signal processor which offers a solution to radar detection and imaging problems of both tactical and strategic importance. This effort combined detailed knowledge of modern signal-processing algorithms with hybrid analog/digital hardware.

In 1979 John was promoted to Assistant Leader, and in 1983 he assumed responsibility as Leader of the Analog Device Technology Group. This group conducted research in a variety of signal-processing technologies and applications, with a yearly budget of $5 million. In 1984, he left Lincoln Laboratory to co-found MICRILOR, a consulting and R&D firm which offers signal-processing technology to government and industry.

He has written over 30 technical papers and numerous internal reports, and holds 2 patents.

8.2 Stanley A. Reible

Stanley A. Reible received the B.S. in Applied Mathematics and Engineering Physics and the M.S. and Ph.D. degrees in Electrical and Computer Engineering from the University of Wisconsin, Madison in 1970, 1971 and 1975, respectively.

His graduate course work was concentrated in the areas of solid state physics and biomedical engineering. In his research work he modeled energy transduction in biological systems and pulse propagation on nonlinear transmission lines, developed and studied electronic circuit analogs of superconductive structures, conceived of new superconductive logic elements and developed fabrication techniques for solid state devices.

In 1975 he joined Lincoln Laboratory, Massachusetts Institute of Technology as a technical staff member. Here he developed analog signal processing devices for radar and communications systems. In his work, he perfected gap-coupled, acoustoelectric convolvers and other surface acoustic wave devices (SAW) which substantially expanded existing analog signal processing capability. He trained technicians and engineers in the fabrication, assembly, evaluation, and implementation of these unique devices. He delivered prototype devices to users, assisted in their application, and transferred the technology of fabricating and assembling these devices to industry. He demonstrated the first programmable, SAW-based, burst-waveform processor.

More recently, he conceived of new superconductive signal processing devices and initiated a program to develop these devices. He established state of the art facilities and techniques for the fabrication and RF evaluation of these extremely wide-bandwidth (>2 GHz) signal processing components. He developed thin film fabrication techniques including reactive ion etching. He demonstrated the first superconductive convolver and the first superconductive chirp-transform subsystem.

In 1984, he left Lincoln Laboratory to co-found MICRILOR, a research and development firm which offers signal processing technology to government and industry. Here he has been active in advising the government and industry on the design and development of ACT, SAW, superconductive and other signal processing components, in evaluating the properties of superconductive materials and components, and in the design of communications and radar subsystems incorporating these components.

He has published about thirty professional papers and written numerous internal reports and proposals.

8.3 Jeffrey H. Fischer

Jeffrey Fischer received the BSEE degree in 1979 and the MEEE degree in 1980 from Cornell University. His studies concentrated in circuit theory, signal processing, and classical feedback and control theory. He participated in a cooperative work-study program at Hewlett Packard Co. and worked at Ampex Corp. during the summer of 1979.

In 1980 he joined the Massachusetts Institute of Technology Lincoln Laboratory as a member of the technical staff in the Analog Device Technology group. There his work involved the development of signal processing algorithms, architectures and circuits for the application of advanced analog signal-processing devices. Mr. Fischer has worked in analog, digital and RF circuit and subsystem design as well as design for system-level applications of advanced technology.

He has designed and built numerous unique circuits for instrumentation, microprocessor-based high-speed control, and wideband communications. He has trained and supervised a team of technicians in the construction and testing of ultra-wideband and highly sensitive circuits.

His work at Lincoln Laboratory has focused on the development of the most advanced SAW-convolver-based spread-spectrum packet-radio data link reported to date. This radio supports up to 60 dB of signal-processing gain at 100 MHz signal bandwidth. It uses direct-sequence spread spectrum for low probability of intercept, antijam communications. The processing gain can be traded off against 11 selectable data rates up to 1.4 Mbps. Multipath diversity combining is used and 3-meter resolution range measurements can be made. Mr. Fischer has authored six papers and given meeting speeches on various aspects of this radio.

In October, 1986, Mr. Fischer joined MICRILOR, Inc., to work on advanced signal processing technology for applications in communications, radar and instrumentation. At MICRILOR, his work includes architectural and circuit design for a variety of communications systems and signal processing subsystems, including a low-earth-orbit Multiple Satellite System, an underwater spread-spectrum data link, a chirp-transform-based transceiver, and a superconducting-component space communications processor. He is currently working on a low-cost spread-spectrum radio data link for personal computer networks. This product will be marketed commercially.

8.4 Kendrick R. Bennett

Kendrick Bennett received the A.S.E.E. from Quincy Junior College in 1983. He is currently enrolled at the University of Lowell Department of Electrical Engineering Technology, where he attends classes in the evening. His studies have been concentrated in circuit theory, digital electronics, control systems and communications.

In 1983 he joined the Massachusetts Institute of Technology Lincoln Laboratory as a member of the support staff in the Analog Device Technology group. Here he assisted in the development of an advanced spread-spectrum packet radio data link and a wideband radar system. Skills were developed in the areas of analog, digital, optical, and RF circuit design and testing, multilayer circuit board design and RF packaging design.

In January, 1986, Mr. Bennett joined MICRILOR Inc. to set up, organize, and maintain a laboratory for development purposes in the area of advanced signal processing. Here he has designed and tested numerous circuits relating to spread spectrum communications, semiconductor-lasers, sonar, and radar. He has carried out the detailed design and construction of a matched filter center-frequency measurement instrument, under contract to the government, for use by several commercial SAW manufacturers.

More recently, he has designed a complete RF and IF front end for a full duplex spread spectrum radio data link, and has performed extensive superconducting resonator measurements and designed RF packaging for use in these types of measurements.

8.5 Selected Publications

J. H. Fischer, J. H. Cafarella, C. A. Bouman, G. T. Flynn, V. Dolat, and R. Boisvert, "Wideband Packet Radio for Multipath Environments," IEEE Trans. Commun., vol. COM-36, pp. 564-576, May 1988.

J. H. Cafarella, "Programmable Transversal Filters: Applications and Capabilities," (Invited), 1987 Ultrasonics Symp. Proc., New York: IEEE, 1987, pp. 31-42.

J. H. Fischer, J. H. Cafarella, D. R. Arsenault, G. T. Flynn, and C. A. Bouman, "Wideband Packet Radio Technology," Proc. IEEE, vol. 75, pp. 100-115, January 1987.

J. B. Green, L. N. Smith, A. C. Anderson, S. A. Reible, and R. S. Withers, "Analog Signal Correlator Using Superconductive Integrated Components," IEEE Trans. on Magn., vol. MAG-23, no. 2, p. 895, March 1987.

J. H. Fischer, J. H. Cafarella, and G. T. Flynn, "SAW Convolvers and Signal Processing in a Packet Radio," Conf. Record IEEE MTT-S 1986, New York: IEEE, June 1986.

S. A. Reible, "Future of Cryogenic Devices for Signal Processing Applications," (Invited), Advanced Signal Processing, Ed. by D. J. Creasey, London: Peter Peregrinus Ltd, 1985, pp. 248-255.

J. H. Fischer, J. H. Cafarella, G. T. Flynn, C. A. Bouman, D. R. Arsenault, J. D. Kurtz and R. R. Boisvert, "A Wideband Packet Radio Based on Hybrid Analog/Digital Signal Processing and Layered Architecture," MILCOM '85 Proc., Vol. S, The Electronic Battle: A New Era in Military Communications, New York: IEEE, October 1985.

J. H. Fischer, "Autocalibrating Circuitry for Processing SAW Convolver Outputs," 1985 Ultrasonics Symp. Proc., New York: IEEE, October 1985.

I. Yao and J. H. Cafarella, "Applications of SAW Convolvers to Spread-Spectrum Communication and Wideband Radar," IEEE Trans. Sonics Ultrason., vol. SU-32, No. 5, pp. 760-770, 1985.

J. H. Cafarella, "Application of SAW Convolvers to Spread-Spectrum Communication" (Invited), 1984 Ultrasonics Symp. Proc., New York: IEEE, 1984.

J. H. Cafarella, "Hybrid Signal Processing for Wideband Communication and Radar," (Invited), Proc. Nat Telesystems Conf., New York: IEEE, 1983, pp. 55-58.

J. H. Cafarella, "Advanced SAW-Based Signal Processing for Packet Communication," (Invited), MILCOM '82 Proc., vol. S, Progress in Spread-Spectrum Communication, New York: IEEE, 1982, pp. 10.6-1 - 10.6.7.

S. A. Reible, "Acoustoelectric Convolver Technology for Spread Spectrum Communications," IEEE Trans. MTT, MTT-29, no. 5, pp. 463-473 1981.

R. P. Baker and J. H. Cafarella, "Hybrid Convolver/Binary Processor Achieves High Processing Gain," 1980 Ultrasonics Symp. Proc., New York: IEEE, 1980, pp. 5-9.

J. H. Cafarella, "Device Requirements for Spread-Spectrum Communication," (Invited), Optical Signal Processing for C3I Bellingham: SPIE, 1980, pp. 53-56.

J. H. Cafarella, "System Aspects of SAW Convolvers," (Invited), Presented at 1980 International Microwave Symp., May 1980, (Unpublished).

J. H. Cafarella, "Surface-Acoustic-Wave Devices for Spread-Spectrum Communication," (Invited), Proc. 11th Conf. on Solid State Devices, Jap. J. Appl. Phys., Vol. 19, Suppl. 19-1, 1980, pp. 667-674.

S. A. Reible and I. Yao, "An Acoustoelectric Burst-Waveform Processor," 1980 Ultrasonic Symp. Proc., New York: IEEE, 1980, pp. 133-138.

I. Yao and S. A. Reible, "Wide Bandwidth Acoustoelectric Convolvers," 1979 Ultrasonics Symp. Proc., New York: IEEE, pp. 701-705.

S. A. Reible, J. H. Cafarella, R. W. Ralston and E. Stern, "Convolvers for DPSK Demodulation of Spread-Spectrum Signals," 1976 Ultrasonics Symp. Proc., New York: IEEE, 1976, pp. 451-455

J. H. Cafarella, W. M. Brown, E. Stern and J. A. Alusow, "Acoustoelectric Convolvers for Programmable Matched Filtering in Spread-Spectrum Systems," Proc. IEEE, vol. 64, pp. 756-759, May 1976.

9 FACILITIES AND EQUIPMENT - MICRILOR

MICRILOR occupies a total of 3400 sq. ft. of space in Wakefield, Massachusetts. This space is divided into 2000 sq. ft. for offices and support rooms, 1000 sq. ft. of laboratory and 400 sq. ft. of SCIF.

Security

MICRILOR, Inc. was granted a Top Secret facility clearance with Secret level storage capabilities in 1985 by the Defense Investigative Service. Facilities for special-access programs are available.

Laboratory

A fully instrumented laboratory with 1000 sq. ft. of space has been established. IBM 286 computers have been installed for automating measurements and for data acquisition and reduction. Cryogenic equipment and a temperature-controlled oven is available for experimental work over a wide temperature range.

Microprocessor development systems are available for integrating microprocessor-based control logic into instrumentation and signal processing subsystems. Hardware and emulation systems are available for integrating field programmable gate arrays into circuit and system designs.

Computation Equipment

Personal computers and printers are available for word processing, calculations and graphics. IBM-type (286 and 386) computers with various software packages are available for computer-aided circuit design and for circuit board and mask layouts. Software is available for the design of transmission-line and other circuits including RF filters, couplers, resonators, and mixer imbedding networks.

A Sun Workstation is available for circuit, component and system modeling. Besides various compilers, the SUN Workstation has MACSYMA for symbolic manipulation and JSPICE for device modeling; moments calculations as well as propagation models.

Electronic Measurement Equipment

Available RF test equipment for making measurements to 20 GHz currently includes oscilloscopes, spectrum analyzers, HP network analyzer, frequency synthesizers, pulse generators, logic analyzers, digital meters, assorted RF components and power supplies. Other measurement equipment is leased as required.

10 CONSULTANTS

Paid consultants will not be utilized to fulfill the terms of this proposal.

11 PRIOR, CURRENT, OR PENDING SUPPORT

There exists no prior, current or pending support for the work described in this proposal.

12 COST PROPOSAL

The charges for the proposed research are detailed on the attached DD633 Contract Pricing Proposal. It is expected that the work would be performed on a fixed-price basis. Progress payments will be required to complete the work.